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Rice University's Baker Institute

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How Much Water Does It Take to Produce a Billion Dollars of Economic Output?

Adding an Economic Value Dimension to Water Footprint Analysis

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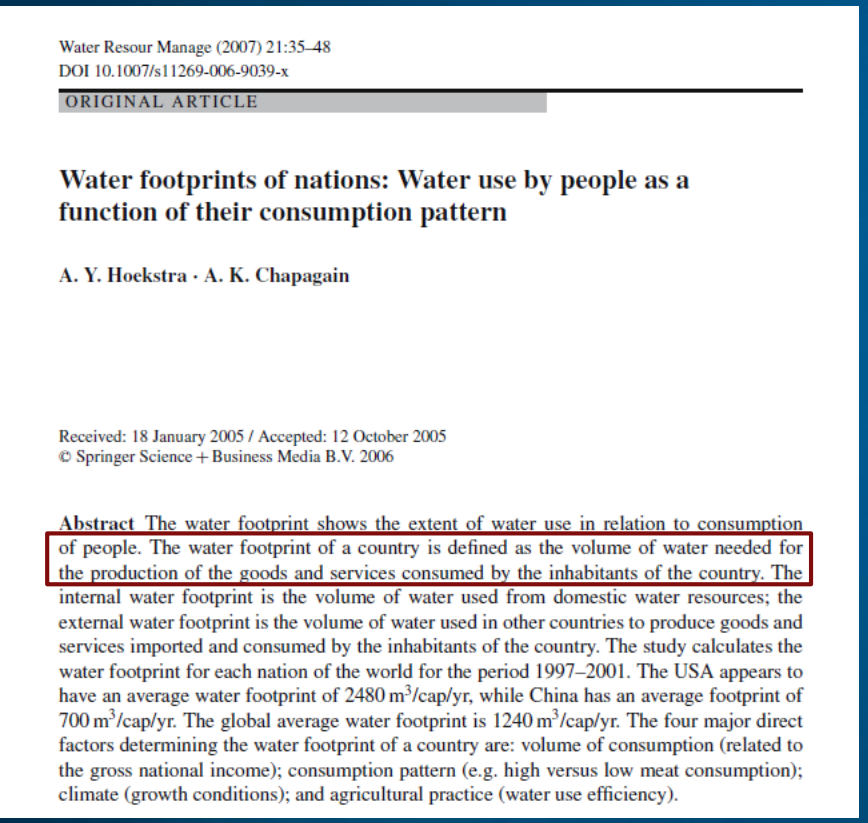
7 March 2017

Intellectual Foundation and Further Evolution



Water Resour Manage (2007) 21:35–48
DOI 10.1007/s11269-006-9039-x

ORIGINAL ARTICLE

Water footprints of nations: Water use by people as a function of their consumption pattern

A. Y. Hoekstra · A. K. Chapagain

Received: 18 January 2005 / Accepted: 12 October 2005

Abstract The water footprint shows the extent of water use in relation to consumption of people. The water footprint of a country is defined as the volume of water needed for the production of the goods and services consumed by the inhabitants of the country. The internal water footprint is the volume of water used from domestic water resources; the external water footprint is the volume of water used in other countries to produce goods and services imported and consumed by the inhabitants of the country. The study calculates the water footprint for each nation of the world for the period 1997–2001. The USA appears to have an average water footprint of 2480 m^3/cap/yr, while China has an average footprint of 700 m^3/cap/yr. The global average water footprint is 1240 m^3/cap/yr. The four major direct factors determining the water footprint of a country are: volume of consumption (related to the gross national income); consumption pattern (e.g. high versus low meat consumption); climate (growth conditions); and agricultural practice (water use efficiency).

- Further operationalize the concept by attaching an economic dimension.

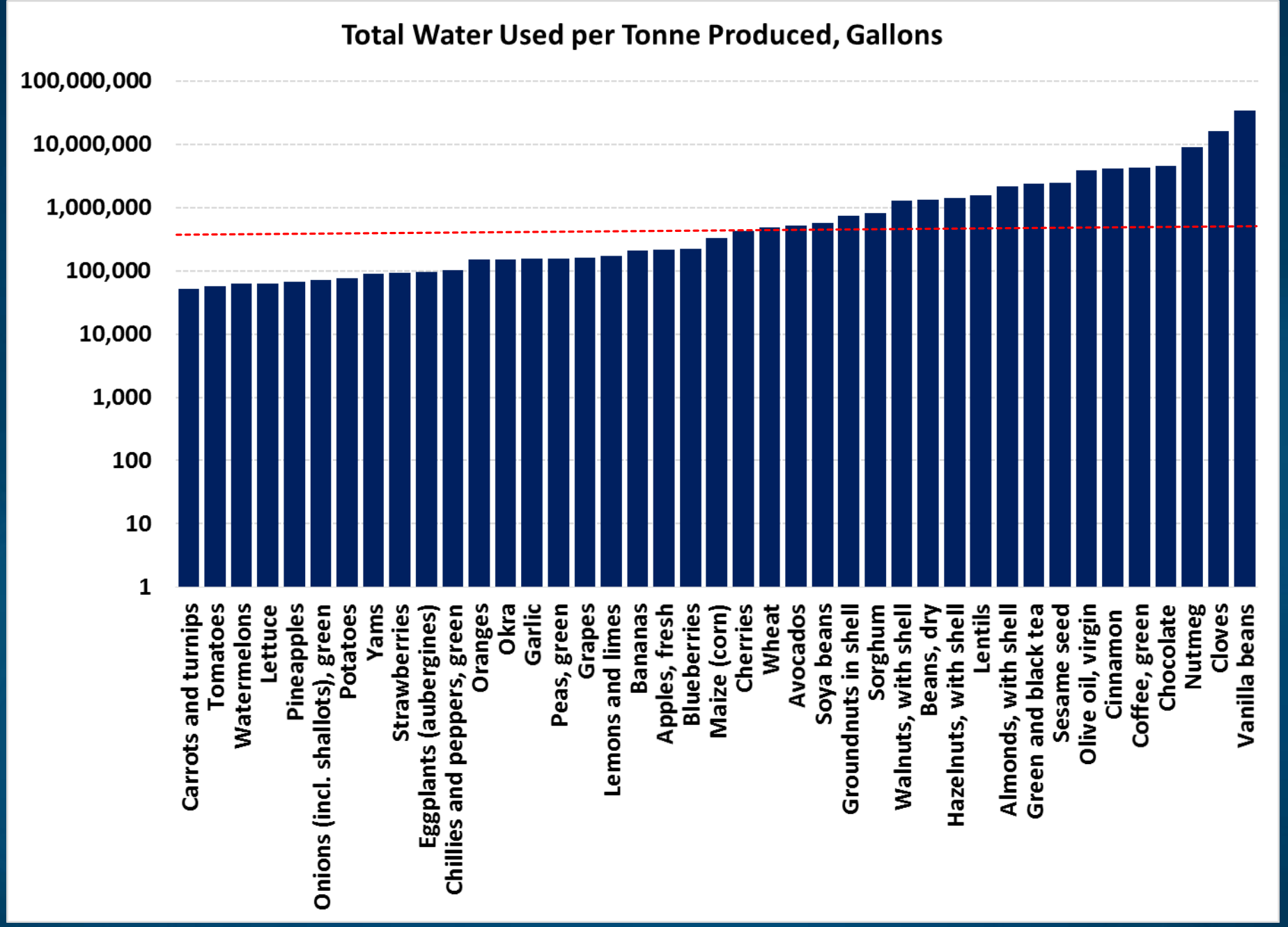
Core Issues

Water Characteristics

- We can't live without it.
- Water is a unique commodity.
  - Generally immutable: use does not alter its fundamental molecular structure.
  - Massively versatile: can serve as catalyst, coolant, lubricant, provider of energy, reaction medium, transport vehicle, etc.
  - Generally systematically underpriced relative to value delivered.
- Quality affects price.
- Uneven distribution of resource drives serious logistical challenges.

Policy Implications

- Think holistically about water, treat it as a key driver of value.
- Educate voting and consuming public by emphasizing the sheer scale of water's presence in everyday good and activities.
- Include economic dimension to improve the caliber and sophistication of political discourse concerning water resource management and water allocation—hugely important Texas and global political issue for decades to come.
- Allow better-informed assessments of economic and environmental tradeoffs in water debates.
  - Sharpen analysis of water project financing.
  - Improve siting of industrial investments.



Source: Hoekstra & Mekonnen

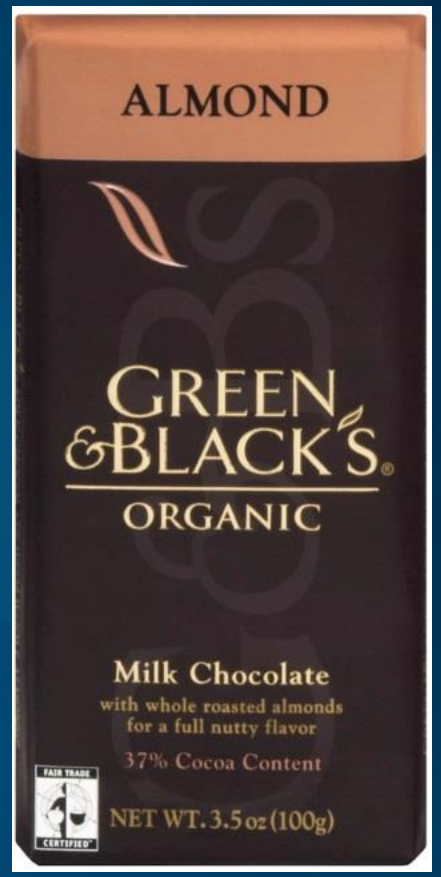
Water Footprints Can Be Deceptive

Uses ~725 gallons of water all in.

The US produced 83 billion eggs in 2015, implying that the "virtual water" content of domestic egg output came out to roughly 15.4 million acre-feet: approximately 50 times the City of Houston's net water use in 2014, according to the TWDB.

Uses ~37 gallons of water all in.

The US market consumed ~1.26 million tonnes of coffee in the 2016/17 market year: nearly 115 billion cups' worth, implying that US coffee drinkers' "virtual water" consumption equaled 95% of Texas' statewide 2014 water use volume.



Uses ~450 gallons of water all in.

U.S. consumers buy roughly 26,000 tonnes of chocolate candies during Valentine's week.

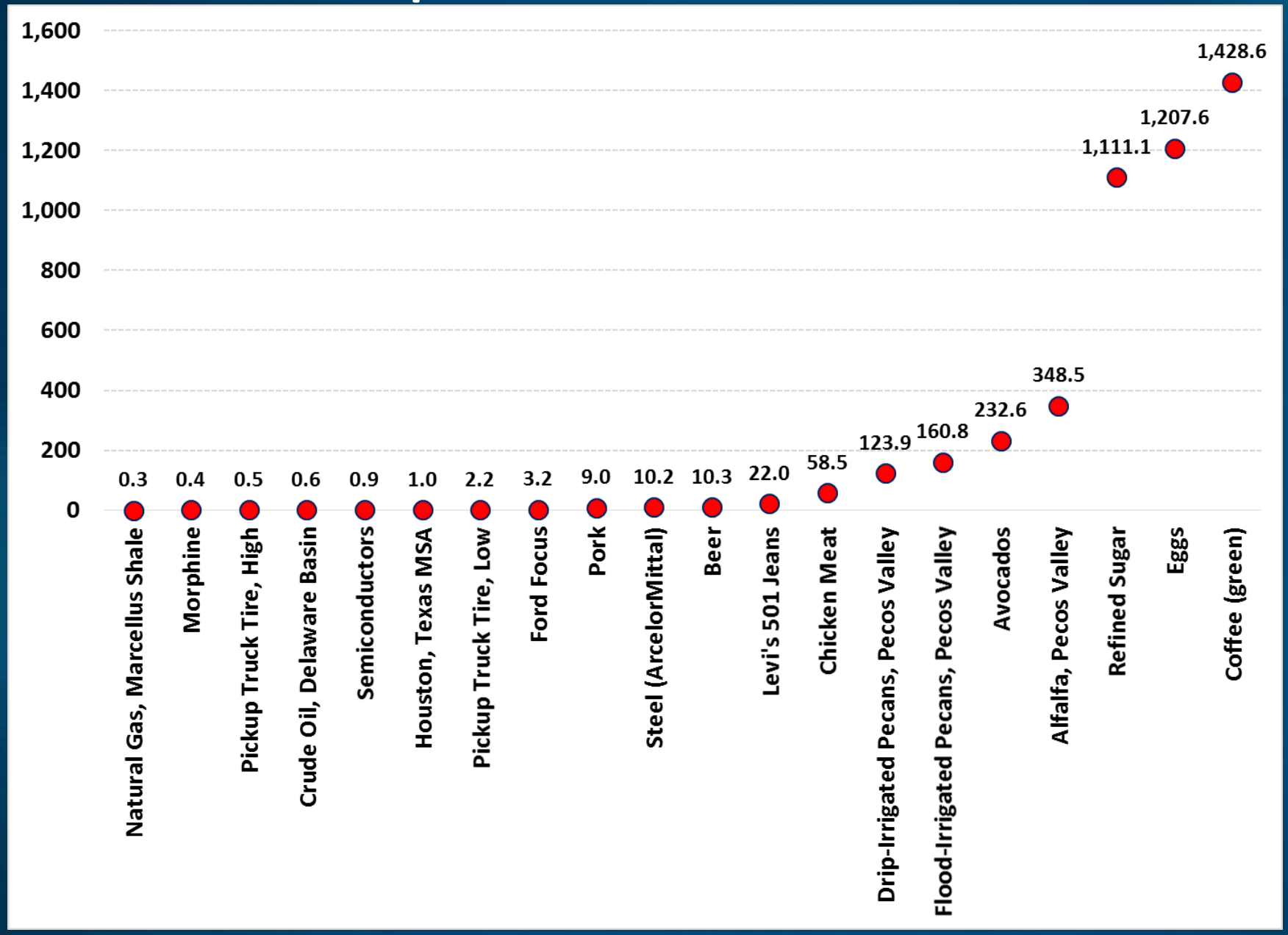
Ethanol Fuel

Crop	Water footprint per litre of biofuel							
	Green	Blue	Grey		Source: http://www.cmegroup.com/trading/energy/ethanol/cbot-ethanol.htm			
	litres water per litre ethanol			Total gal of water per gal of ethanol	Ethanol CBOT March 2017 Price, 20 Feb. 2017 (USA), USD/gal	USD per AF in Economic Value Generated	AF of water per Billion USD in Economic Value Generated	Gallons of water per 20 gal gasoline tank fill*
Crop	Water footprint per litre of ethanol							
	Green	Blue	Grey					
Sugar beet	736	229	223	314	$1.52	$1,578	633,689	628
Sugar cane	1,400	575	132	557	$1.52	$890	1,123,892	1,113
Potatoes	1,458	251	483	579	$1.52	$855	1,169,232	1,158
Cassava	2,477	1	60	671	$1.52	$739	1,353,791	1,341
Maize	2,212	190	453	754	$1.52	$657	1,522,881	1,509
Barley	2,796	182	302	867	$1.52	$572	1,749,580	1,733
Rye	3,271	58	229	940	$1.52	$527	1,897,868	1,880
Rice, paddy	2,640	785	430	1,018	$1.52	$486	2,056,290	2,037
Wheat	2,943	789	478	1,112	$1.52	$445	2,245,650	2,225
Sorghum	6,585	237	201	1,855	$1.52	$267	3,746,128	3,711

*Assuming 10% ethanol by volume

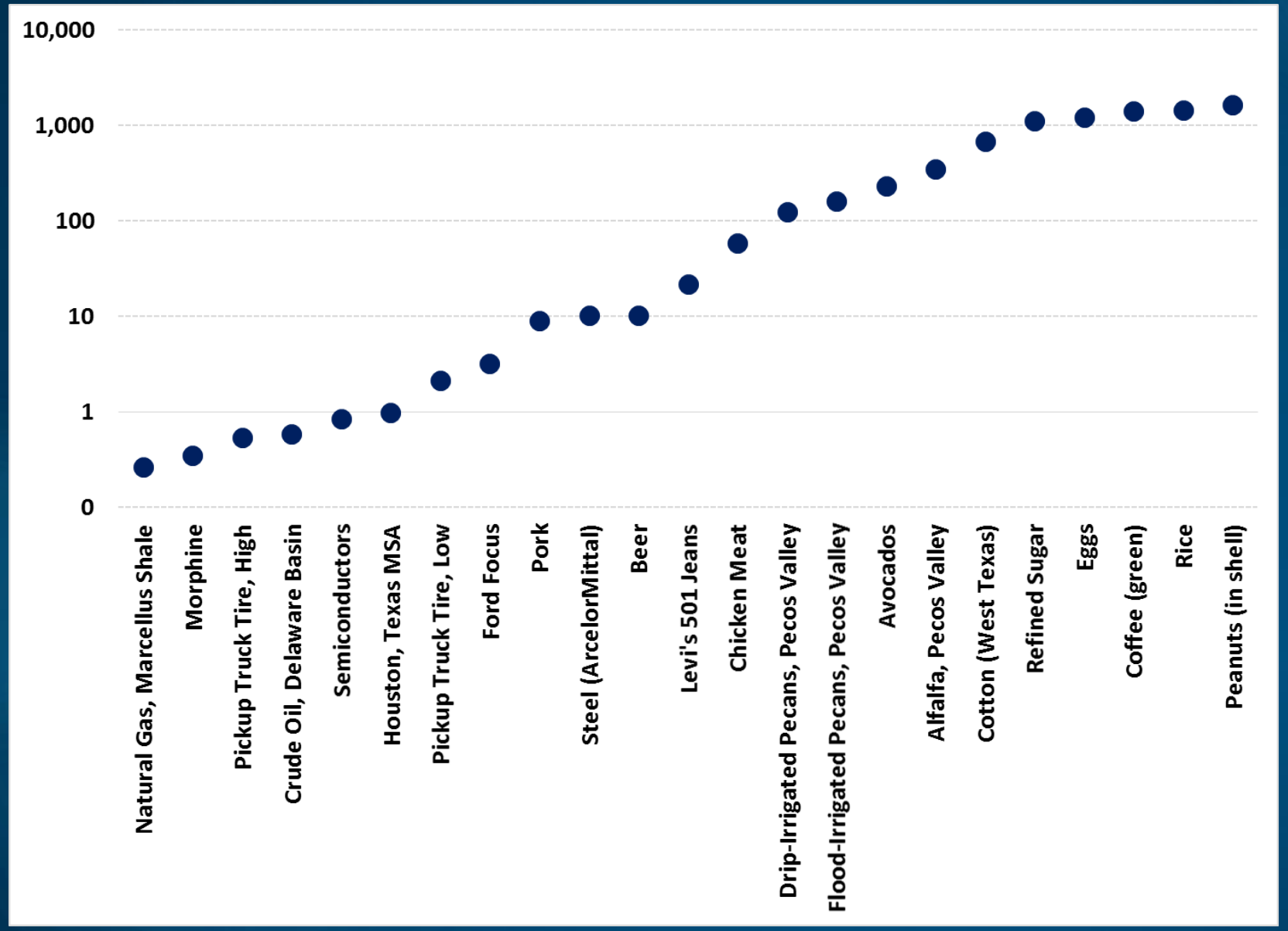
M.M. Mekonnen and A.Y. Hoekstra, "The green, blue and grey water footprint of crops and derived crop products," December 2010

Gallons of Water per Dollar of Economic Value Generated



Source: Company Reports, EIA, FracFocus, Hoekstra & Mekonnen, Journal Articles, TWDB, USDA

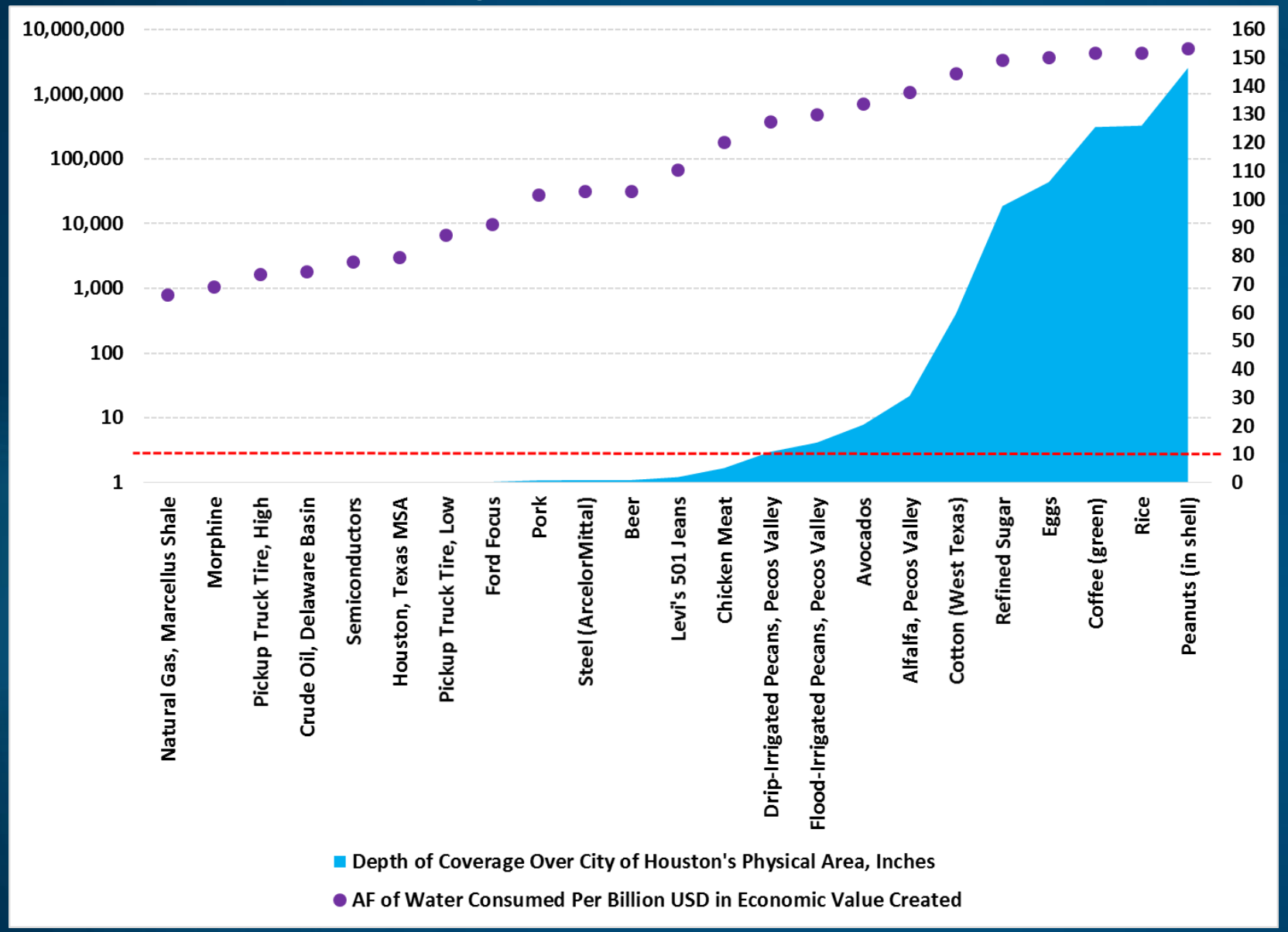
Gallons of Water per Dollar of Economic Value Generated: Orders of Magnitude



Source: Company Reports, EIA, FracFocus, Hoekstra & Mekonnen, Journal Articles, TWDB, USDA

	Direct economic value generated per gallon of water used	Gallons of water needed to create $1 in direct economic value	AF of Water Consumed Per Billion USD in Economic Value Created	Depth of Coverage Over City of Houston's Physical Area, Inches
Natural Gas, Marcellus Shale	$3.804	0.3	807	0.02
Morphine	$2.847	0.4	1,078	0.03
Pickup Truck Tire, High	$1.845	0.5	1,663	0.05
Crude Oil, Delaware Basin	$1.692	0.6	1,814	0.05
Semiconductors	$1.170	0.9	2,623	0.08
Houston, Texas MSA	$1.008	1.0	3,045	0.09
Pickup Truck Tire, Low	$0.465	2.2	6,604	0.19
Ford Focus	$0.313	3.2	9,808	0.28
Pork	$0.111	9.0	27,578	0.79
Steel (ArcelorMittal)	$0.098	10.2	31,359	0.90
Beer	$0.097	10.3	31,577	0.90
Levi's 501 Jeans	$0.046	22.0	67,447	1.93
Chicken Meat	$0.017	58.5	179,422	5.14
Drip-Irrigated Pecans, Pecos Valley	$0.008	123.9	380,275	10.89
Flood-Irrigated Pecans, Pecos	$0.006	160.8	493,488	14.13
Avocados	$0.004	232.6	713,695	20.43
Alfalfa, Pecos Valley	$0.003	348.5	1,069,458	30.61
Cotton (West Texas)	$0.001	678.8	2,083,168	59.63
Refined Sugar	$0.001	1111.1	3,409,875	97.61
Eggs	$0.001	1207.6	3,706,080	106.09
Coffee (green)	$0.001	1428.6	4,384,125	125.50
Rice	$0.001	1434.4	4,401,954	126.01
Peanuts (in shell)	$0.001	1666.7	5,114,812	146.42

Acre-Feet of Water per Billion Dollars of Economic Value Generated



Source: Company Reports, EIA, FracFocus, Hoekstra & Mekonnen, Journal Articles, TWDB, USDA

Huge Pricing Variations

Groundwater Rights Sales Contract

This Contract ("**Contract**") to buy and sell groundwater rights is between Sellers, Winkler Services and Buyer, all as identified below. Buyer must deliver the Earnest Money to Escrow Agent and obtain a signature acknowledging receipt of the Earnest Money before the Earnest Money Deadline provided in paragraph A.1. for this Contract to be effective. For and in consideration of the mutual covenants set forth herein, and other good and valuable consideration, the receipt and sufficiency of which is herein acknowledged, Sellers, Winkler Services and Buyer hereby agree as follows:

Sellers: **Roark Resources, Inc., Murray B. Roark, the Estate of Bill B. Roark, James C. Roark, George H. Roark, and Robert B. Roark (collectively, the "Roark Parties") and Winkler Land, LLC ("Winkler Land", and collectively with the Roark Parties, the "Sellers")**

Roark Parties: **(listed above)**

Address: c/o Murray B. Roark
2609 Dame Brison
Lewisville, TX 75056

Phone: (214) 442-2901

Fax: _____

E-mail: pap@roarkresources.com

SCHEDULE 1

ROYALTY RATE

Buyer shall, in addition to the Cash Portion of Purchase Price, p
for Groundwater produced, transported, used or sold from the
permitted assignees or successors, calculated and subject to fu
with the further terms of this Schedule 1, provided that such ro
reduction or offset for any costs, expenses or fees (including v
governmental charges) incurred by Buyer, its permitted assign
person or entity.

Subject to the further terms of this Schedule 1, for each
produced from the Real Property by Buyer or its permitted assigns or successors, Buyer shall pay Winkler Services a base royalty of $0.10. In addition to the base royalty, the Buyer will pay an additional royalty based on the quality of the Groundwater produced as described below -

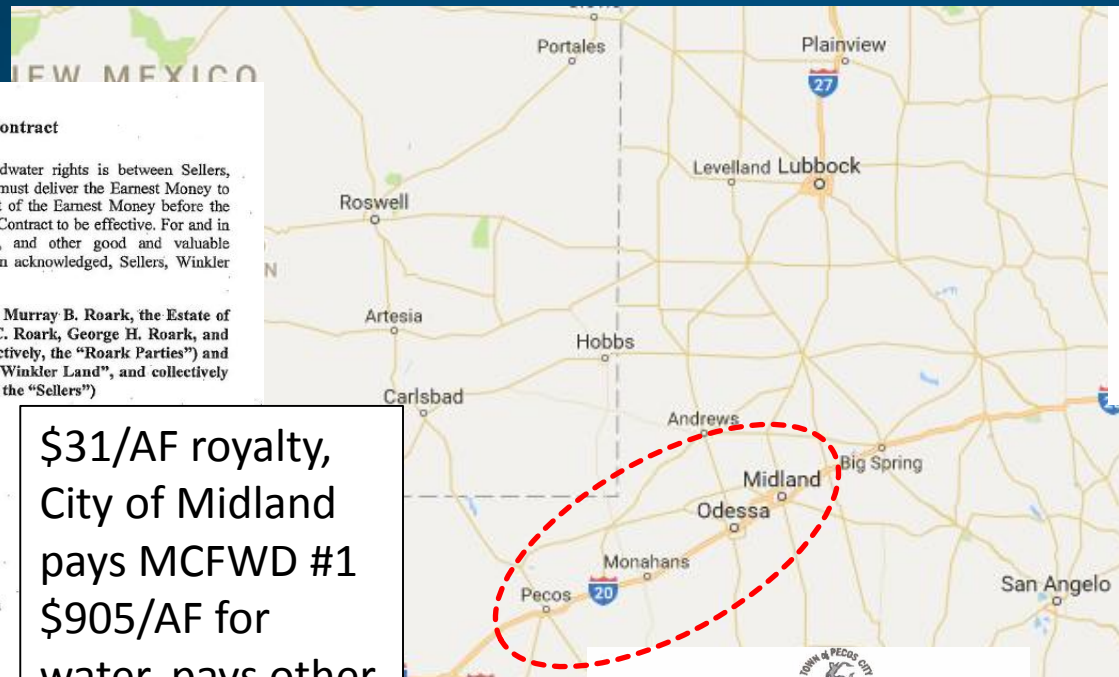
All raw Groundwater produced from the Real Property having a total dissolved solids (TDS) content less than 700 milligrams per liter (mg/L) will have a graduated additional royalty based on the following:

700 mg/L > TDS => 600	Additional Royalty = $0.005/1,000 gallons produced
600 mg/L > TDS => 500	Additional Royalty = $0.010/1,000 gallons produced
500 mg/L > TDS => 400	Additional Royalty = $0.015/1,000 gallons produced
400 mg/L > TDS => 300	Additional Royalty = $0.020/1,000 gallons produced
300 mg/L > TDS	Additional Royalty = $0.025/1,000 gallons produced

All Groundwater produced from the Real Property having a maximum contaminant level of arsenic (MCL As) less than 0.070 milligrams per liter (mg/L) will have a graduated increase in royalty based on the following:

0.070 mg/L > MCL As => 0.060	Additional Royalty = $0.005/1,000 gallons produced
0.060 mg/L > MCL As => 0.050	Additional Royalty = $0.010/1,000 gallons produced
0.050 mg/L > MCL As => 0.040	Additional Royalty = $0.015/1,000 gallons produced
0.040 mg/L > MCL As => 0.030	Additional Royalty = $0.020/1,000 gallons produced
0.030 mg/L > MCL As	Additional Royalty = $0.025/1,000 gallons produced

$31/AF royalty, City of Midland pays MCFWD #1 $905/AF for water, pays other sources $130-163/AF



TOWN OF PECOS CITY

RESALE OF WATER
PERMIT APPLICATION

APPLICANT: Chevron USA Inc
COMPANY: Chevron USA INC
ADDRESS: 15 Smith Road
Midland Texas 79705

I hereby apply to the Town of Pecos City for the purchase of water with the purpose of resale, and hereby agree to comply with the rates, rules and regulations of the Town of Pecos City Water and/or Sewer System and Texas Commission on Environmental Quality (TCEQ) regulations §290.44(h), Backflow, siphonage (see attached information).

Information on water uses:
Water from the Wheeler County Water Cor. (and Stinnett Town) would be intermingled and used to support oil drilling, completions and on/ work in Southern Wheeler & Northern Roberts Counties, Texas

Information on water tap:
Size of water tap: 8" 4" port
Size of water meter: 3"
Air gap assembly: ☒ Installed ☐ Not Installed
Back flow prevention assembly: ☒ Installed ☐ Not Installed

Information on Volume of water:
The Maximum estimated amount of water used per month will be 1 MILLION gallons Chevron USA Inc
Signed S K Beckham / Attorney-in-fact Applicant

PERMIT NO. 011
Approved by city council on August 20 15
Permit issued on this 28th day of August in the year of 2015

Mary Carmen Wood City Secretary $15 /1Kgal

-Subject to increase from time to time as the city pushes the sale of effluent instead.

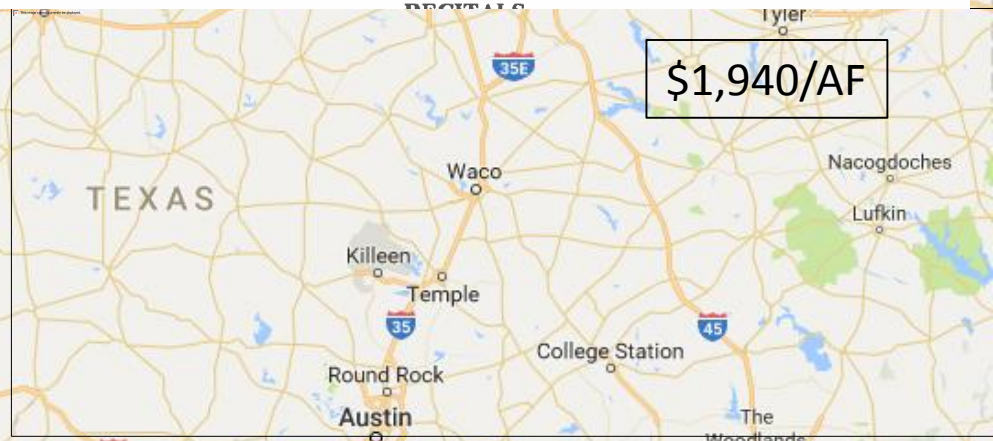
$3,879/AF

THE STATE OF TEXAS §
§
COUNTY OF ECTOR §

RECLAIMED WATER SUPPLY AGREEMENT

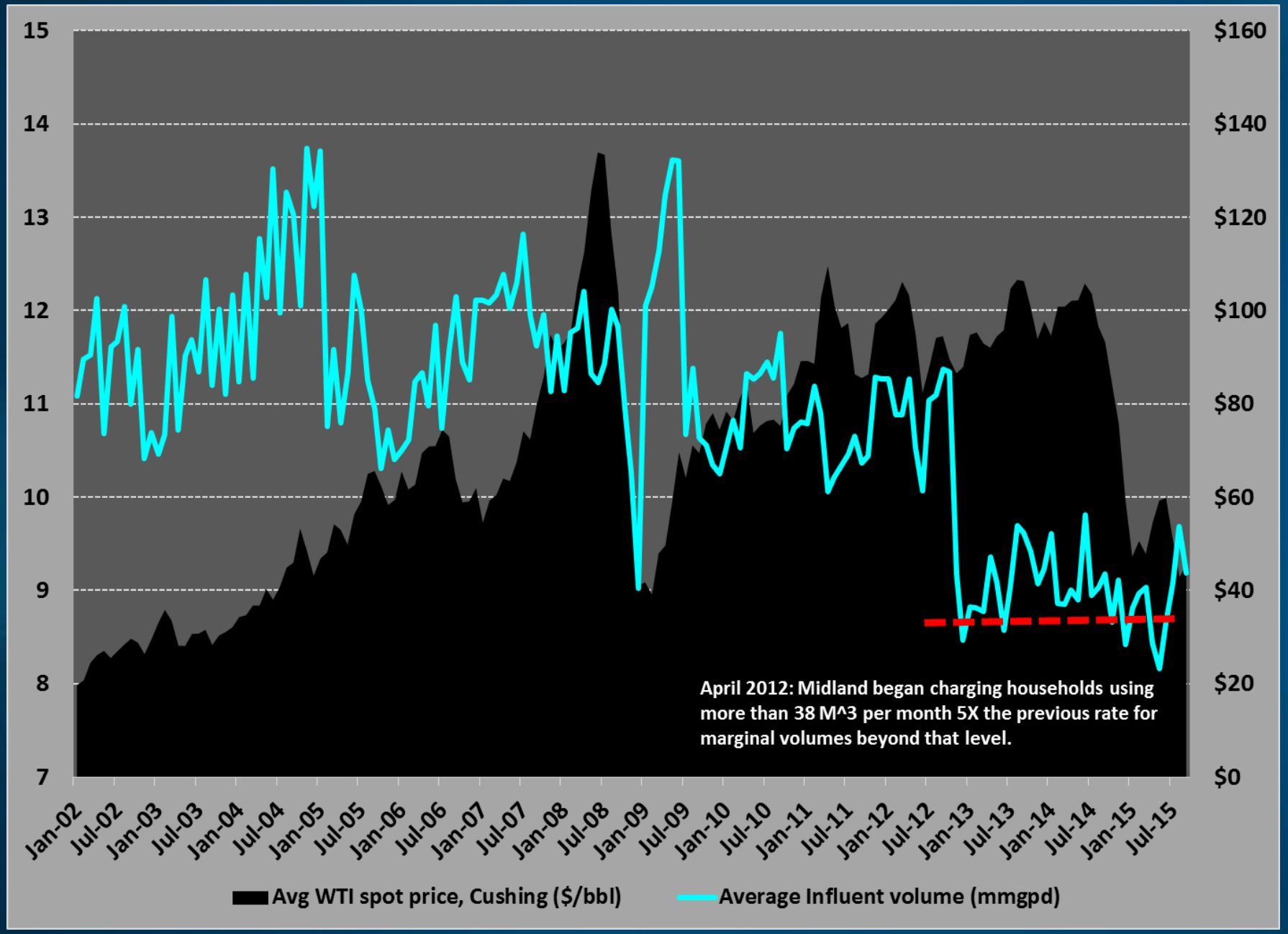
This Reclaimed Water Supply Agreement ("Agreement") is entered into by and between the City of Odessa, Texas, a municipal corporation, in Ector and Midland Counties, Texas, a municipal home rule city, and Pioneer Natural Resources USA, Inc., and is expressly made effective on this, the 8th day of August, 2014.

RECITALS



$1,940/AF

Water Pricing Changes Consumer Behavior: Midland, TX



- Influent volumes entering the city's wastewater treatment plant structurally declined upon imposition of 500% price increase for water usage above 10,000 gallons per month.
- This decline happened in spite of Midland's rapid population and income growth during peak of 2010-2014 oil boom.

Water Footprint Models By Good

Northern Delaware Basin Oil Well

			Source
Well Name	Thor 21 Federal Com #703H		FracFocus
Gallons of Water Used in Completion	13,303,781		FracFocus
Operator	EOG Resources		FracFocus
Layer	Upper Wolfcamp		NM OCD
Typical Northern Delaware Wolfcamp well EUR, BOE	600,000		EOG Investor Presentation
Typical Northern Delaware Wolfcamp well EUR, broken down by hydrocarbon type	50%	Oil	EOG Investor Presentation
	24%	NGL	EOG Investor Presentation
	26%	Gas	EOG Investor Presentation
Commodity price as of 27 September 2016	$52.94	Per bbl	WTI Spot, Cushing, EIA (2017 average price through 2 March 2017)
	$26.51	Per boe	US Natural Gas Liquid Composite Spot Price, https://www.eia.gov/dnav/ng/hist/ngm_epg0_plc_nus_dmmbtum.htm, prices quoted per mmbtu, converted into bbl under assumption that a barrel of oil contains approximately 5.8 mmbtu in heat content. 2016 average price through 28 Feb. 2017.
	$17.98	per boe	US Natural Gas Henry Hub Spot Price, http://www.eia.gov/dnav/ng/ng_pri_fut_s1_d.htm, prices quoted per mmbtu, converted into bbl under assumption that a barrel of oil contains approximately 5.8 mmbtu in heat content. 2017 average price through 27 September 2016.
Prospective total value of commodity produced over lifetime of well	$15,882,000	Oil	
	$3,816,864	NGL	
	$2,804,880	Natgas	
Direct economic value produced per gallon of water used	$1.69		

Marcellus Shale High-End Gas Well

			Source
Well Name	Claysville Sportsmans Unit #9H		FracFocus
Gallons of Water Used in Completion	12,493,323		FracFocus
Operator	Range Resources Corporation		FracFocus
Layer	Marcellus		FracFocus
Typical SW Marcellus dry gas well EUR	18	Billion Cubic Feet	RRC Corporate Presentation, August 2016
Commodity price as of 28 Feb. 2017	$3.10	Per mmbtu	US Natural Gas Henry Hub Spot Price, http://www.eia.gov/dnav/ng/ng_pri_fut_s1_d.htm, prices quoted per mmbtu. 2017 average price through 28 Feb. 2017.
Marcellus Basis Discount	$0.40	Per mmbtu	RRC Corporate Presentation, August 2016
Prospective Total Value of commodity produced over lifetime of well	$47,520,000		
Direct Economic Value Produced per gallon of water used	$3.80		

Pecos Valley Alfalfa

			Source
Alfalfa Water Use (Carlsbad, NM)	38.6	in	Harry F. Blaney and Eldon G. Hanson, "Consumptive Use and Water Requirements in New Mexico," Technical Report 32, New Mexico State Engineer, Pg.19
Pecos, TX annual precipitation	10.48	in	"Period of Record Monthly Climate Summary: Pecos, TX," Western Regional Climate Center, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?tx6892
Implied irrigation need	28.12	in	
Volume per acre	102,076	cubic feet	
Cubic feet per gallon	0.134		
Sprinkler Efficiency	92%		Yonts et.al, "Water Loss from Above-Canopy and In-Canopy Sprinklers," University of Nebraska Extension, http://extensionpublications.unl.edu/assets/html/g1328/build/g1328.htm
Implied Water Needed Per Acre	827,998	gallons	
Sprinkler-irrigated alfalfa yield per acre, annual	9	tons	Laurialt et.al, "The 2015 New Mexico Alfalfa Variety Test Report," New Mexico State University, aces.nmsu.edu/pubs/variety_trials/AVT15.pdf
Sprinkler-irrigated alfalfa yield per acre, annual	17,280	lbs	
Water use per lb of alfalfa	48	gallons	
Estimated Annual Water Needs of 640 Acre ("One Section") Alfalfa Farm, Gallons	**529,918,754**	**gallons**	
Estimated Annual Water Needs of 640 Acre ("One Section") Alfalfa Farm, Barrels Per Day	**34,567**	**BPD**	
Alfalfa Price, Pecos, TX	$275.00	per ton	"Weekly Texas Hay Report," 30 September 2016, USDA, https://www.ams.usda.gov/mnreports/am_gr310.txt
Alfalfa Price, Pecos, TX	$0.14	per lb	"Weekly Texas Hay Report," 30 September 2016, USDA, https://www.ams.usda.gov/mnreports/am_gr310.txt
Alfalfa Estimated Economic Output Per Gallon	**$0.003**		

Pecos Valley Pecans

Drip		Flood		
Pecan Water Use (Est. Permian Basin, Texas)	55	55	in	A. Zan Matthies, Jr., "Permian Basin Nuts," Vol. 3, Issue 1, May 2011, Texas AgriLife Extension Service, midland.agrilife.org/files/2011/08/NL_PB-NUTS_v3i1_05-2011_1.pdf
Pecos, TX annual precipitation	10.48	10.48	in	"Period of Record Monthly Climate Summary: Pecos, TX," Western Regional Climate Center, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?tx6892
Implied irrigation need	44.52	44.52	in	
Trees Per Acre (Mature Orchard)	20	161,608	cubic feet	Lenny Wells, "Establishing a Pecan Orchard (B 1314)," UGA Extension, http://extension.uga.edu/publications/detail.cfm?number=B1314
Volume per day per mature tree	190	-	gal	A. Zan Matthies, Jr., "Permian Basin Nuts," Vol. 3, Issue 1, May 2011, Texas AgriLife Extension Service
Growing season length	225	-	days	A. Zan Matthies, Jr., "Permian Basin Nuts," Vol. 3, Issue 1, May 2011, Texas AgriLife Extension Service
Volume per acre	855,000	1,206,027	gallons	
Sprinkler Efficiency	92%	n/a		Yonts et.al, "Water Loss from Above-Canopy and In-Canopy Sprinklers," University of Nebraska Extension, http://extensionpublications.unl.edu/assets/html/g1328/build/g1328.htm
Implied Water Needed Per Acre	929,348	1,206,027	gallons	
Pecan yield per acre	2,500	2,500	lbs	"Grower improves yield with new sunlight management technique," Western Farm Press, http://westernfarmpress.com/grower-improves-yield-new-sunlight-management-technique
Water use per lb of Pecans, In Shell	372	482	gallons	
Pecan Wholesale Price	$3.00	$3.00	per lb	USDA Pecan Report, 26 January 2016, http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=22768
Pecans Estimated Economic Output Per Gallon	**$0.008**	**$0.006**		

Chicken Meat

			Source
Finished bird weight	4.05	kg	"Nutrient requirements of meat chickens (broilers)," Poultry Hub, http://www.poultryhub.org/nutrition/nutrient-requirements/nutrient-requirements-of-meat-chickens-broilers/
Feed consumption	8.5	kg	Id.
Corn percentage	61%	by mass	"Poultry Nutrition and Feeding," Animal Nutrition Handbook, www.ag.auburn.edu/~chibale/an12poultryfeeding.pdf
Soybean meal percentage	22%	by mass	"Poultry Nutrition and Feeding," Animal Nutrition Handbook, www.ag.auburn.edu/~chibale/an12poultryfeeding.pdf
Corn irrigation water footprint, per kg (US avg.)	17	gallons	Mekkonnen et.al, "The green, blue and grey water footprint of farm animals," Value of Water Research Report Series Number 48, doc.utwente.nl/76914/1/Report-48-WaterFootprint-AnimalProducts-Vol1.pdf
Soybean irrigation water footprint, per kg (US avg.)	24	gallons	Id.
Total grain feed water use to bring broiler chicken to slaughter weight	130	gallons	
Broiler chicken lifetime drinking water requirement	4	gallons	"Broiler Water Consumption," The Poultry Site, 1 December 2009, http://www.thepoultrysite.com/articles/1557/broiler-water-consumption/
Broiler dressing percentage	71%		Jeannine P. Schweihofer, "Carcass Dressing Percentage and Cooler Shrink," Michigan State University Extension, 9 May 2011, http://msue.anr.msu.edu/news/carcass_dressing_percentage_and_cooler_shrink
Meat Produced, per bird	2.8755	kg	
Wholesale chicken meat value	$0.80	$/lb	"Livestock, Dairy, and Poultry Outlook," USDA, 16 September 2016, http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1350
Total bird value	$2.30		
Direct economic value per gallon of water consumed	**$0.02**		

Beer

			Source
Barley used per barrel of beer	68.7	lbs	Jennifer K. Bond et.al., "Expanding Craft Beer Production Boosts Industrial Use of Barley," 4 May 2015, http://www.ers.usda.gov/amber-waves/2015-may/expanding-craft-beer-production-boosts-industrial-use-of-barley.aspx#.V_LXY_nx7IU
Hops used per barrel of beer	2	lbs	Greg Goldstone, "Will a Shortage of Hops Kill Craft Beer?" Gear Patrol, 14 August 2015, http://gearpatrol.com/2015/08/14/will-hops-shortage-kill-craft-beer/
Barley cultivation irrigation water usage	53,891	gallons/tonne	Mekkonnen et.al, "The green, blue and grey water footprint of farm animals," Value of Water Research Report Series Number 48, doc.utwente.nl/76914/1/Report-48-WaterFootprint-AnimalProducts-Vol1.pdf
Hops Yield	2,000	lbs/acre	"Hops: Acreage, Yield, Production, Price, and Value Washington, 2001-2010," https://www.nass.usda.gov/Statistics_by_State/Washington/Publications/Annual_Statistical_Bulletin/2011/ab57-58.pdf
Hops total water demand per lb, est. (Yakima Valley, WA)	375	gallons	
Yakima Valley hops annual water need	28	in	Graham Ollard, Extension Presentation, http://www.uvm.edu/extension/cropsoil/wp-content/uploads/Ollard_Growing_Hops-Fertility_Water_Pests_2-22-13.pdf.
Yakima, WA annual precipitation	7.98	in	Id.
Net hopsirrigation water needs, annual	20.02	in	
Net hops irrigation water needs	543,591	gallons per acre	
Net irrigation water needs	272	gallons per lb/hops	
Hops cultivation water usage, est. (Yakima Valley, WA)	544	gallons per barrel of beer	
Barley cultivation water usage, est.	1,680	gallons per barrel	
Brewing and Operational Water Usage, Per barrel Produced	3.29	barrels	"Efficient Water Use in Our Breweries," 2015 Stewardship Report, MillerCoors, http://www.millercoors.com/sustainability/environmental-stewardship/water-stewardship
Total water usage in beer production	2,325	gallons per barrel	
Total water usage in beer production	75	gallons per gallon of beer	
Beer value per gallon	$7.29		Boston Beer Company, 2015 10-K Report
Direct economic value per gallon of water used	**$0.10**		

Steel (ArcelorMittal)

	2013	2014	2015	Units
Water Intake Per Tonne of Steel Produced	23.1	23.3	24.0	M^3
Water Consumed Per Tonne of Steel Produced	4.2	4.7	5.1	M^3
Water Intake Per Tonne of Steel Produced	6,111	6,164	6,349	Gallons
Water Consumed Per Tonne of Steel Produced	1,111	1,243	1,349	Gallons
Weighted Average ArcelorMittal Steel Sales Price	$798	$725	$621	USD/tonne
Value generated per gallon of water intake	$0.131	$0.118	$0.098	
Value generated per gallon of water consumed	$0.718	$0.583	$0.461	
AF per billion USD of economic value generated			31,359	
	2013	2014	2015	
NAFTA Steel Shipments, kt	22,500	23,074	21,306	
Brazil Steel Shipments, kt	9,797	10,376	11,540	
Europe Steel Shipments, kt	38,269	39,639	40,676	
ACIS Steel Shipments, kt	12,422	40,676	12,485	
Total steel shipments, kt	82,988	113,765	86,007	
NAFTA Average Steel Selling Px, $/tonne	$829	$843	$742	
Brazil Average Steel Selling Px, $/tonne	$940	$867	$647	
EuropeAverage Steel Selling Px, $/tonne	$804	$773	$609	
ACIS Average Steel Selling Px, $/tonne	$613	$576	$432	
Weighted Average Steel Selling price	$798.24	$725.33	$621.35	
Source	ArcelorMittal, "2015 Performance," http://corporate.arcelormittal.com/sustainability/reporting-hub/2015-performance, ArcelorMittal 2015 Annual Report			

Semiconductors

	2011	2012	2013	2014	2015
Water Consumption, M^3					25,000,000
Water Consumption, Gallons	0	0	0	0	6,604,304,421
Sales				$4,355,000,000	$5,645,000,000
Gallons Per $ of Sales	#DIV/0!	#DIV/0!	#DIV/0!	$0.00	$1.17
Value created per liter of water input	#REF!	#REF!	#REF!	#REF!	-
Value created per gallon	#REF!	#REF!	#REF!	#REF!	$1.17
Value created per AF	#REF!	#REF!	#REF!	#REF!	$381,226
AF per billion USD of economic value created	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**2,623**
Source	GlobalFoundries Company CSR Report, EE Times Europe				

Morphine

Morphine derived from opium cultivated in Tasmania (GSK)		
Quantity of morphine sulfate	100	mg
Value of Morphine sulfate	$0.06	mg
Value of 100 mg of Morphine sulfate	$5.87	
Water Required For Producing 100 mg of Morphine Sulfate (All-in)		
Farming	**6.7**	**liters**
Other	**1.1**	**liters**
Total	**7.8**	**liters**
Value created per liter of water input	**$0.75**	
Value created per gallon	**$2.85**	
Value created per AF	**$927,745**	
AF per billion USD of economic value created	**1,078**	
Source	AthenaHealth (morphine sulfate pricing), : McAlister S, Ou Y, Neff E, et al. The Environmental footprint of morphine: a life cycle assessment from opium poppy farming to the packaged drug. BMJ Open 2016;6: e013302. doi:10.1136/ bmjopen-2016-013302	

Pork

Water Footprint of Pork From Farm-to-Fork		
4 oz serving of boneless pork	8.2	gal
1 lb of boneless pork	32.8	gal
Pork Fresh Tenderloin Retail Price, USDA Natl. Avg, $/lb	$3.65	
Economic Value Generated, USD/Gal	$0.11	
Economic Value Generated, USD/AF	$36,261	
AF/Billion USD in Economic Value Generated	27,578	
Source	Pork Checkoff Report Newsletter, October 2014, http://www.pork.org/checkoff-reports/measuring-porks-water-footprint/	

Ford Focus

Focus 2012 ICEV Life Cycle Water Withdrawal				Focus 2012 ICEV Life Cycle Water Consumption		
	Withdrawal (m3)	Gallons			Consumption (m3)	Gallons
Materials	123	32,496		Materials	16	4,227
Manufacturing	77	20,343		Manufacturing	4	1,057
Assembly	48	12,681		Assembly	3	793
Fuel Production	260	68,690		Fuel Production	107	28,269
End of Life	23	6,076		End of Life	1	264
Total Withdrawals For Production		65,520		Total Water Consumption for Production		6,076
Original MSRP for 4-Door Select Sedan		$20,500		Original MSRP for 4-Door Select Sedan		$20,500
Economic Value Generated Per Gallon Withdrawn		$0.31		Economic Value Generated Per Gallon Consumed		$3.37
Economic Value Generated per AF Withdrawn		$101,953		Economic Value Generated per AF Consumed		$1,099,316
AF/Billion USD in Economic Value Generated		9,808		AF/Billion USD in Economic Value Generated		910
Source	https://corporate.ford.com/microsites/sustainability-report-2014-15/environment-water-usage.html					

Eggs

Large Eggs Produced in USA		
Water Used to Produce 1 Metric Tonne of Eggs	3265	M^3
Water Used to Produce 1 Metric Tonne of Eggs	862,593	gal
Shell as % of total egg mass	10.50%	
Water Used to Produce 1 Metric Tonne of "Edible Egg Material."	963,791	gal
Weight of 1 Large Egg	70	g
Total Egg Weight of Dozen Large Eggs	840	g
Total 'Edible Weight"of Dozen Large Eggs	752	g
Cartons of One Dozen Large Eggs Needed to Produce 1 Tonne of "Edible Egg"	1,330	
Price of 1 Dozen Large Eggs, USDA IA-MN-WI Wholesale	$0.60	
Economic Value Produced, tonne of "edible egg"	$798	
Economic Value Produced, USD/Gal	$0.0008	
Economic Value Produced, USD/AF	$270	
AF/Billion USD in Economic Value	**3,706,080**	

Source	Mesfin M. Mekonnen* and Arjen Y. Hoekstra, "A Global Assessment of the Water Footprint of Farm Animal Products," Ecosystems (2012) 15: 401–415, DOI: 10.1007/s10021-011-9517-8; Pelletier et.al, "Comparison of the environmental footprint of the egg industry in the United States in 1960 and 2010," https://www.ncbi.nlm.nih.gov/pubmed/24570445, USDA (egg pricing)
Date of Study	2012

Levi's 501 Jeans

One Pair of Jeans

Raw Materials

Growing the Cotton

Manufacturing

Creating the Fabric Cutting, Sewing, and Finishing

Putting to Market

Packaging and Sundries

678 gallons

71 gallons

20 gallons

769 gallons total water

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$34.99 per pair of 501 Original Fit Jeans

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$0.046 per gallon of water used

Source: http://levistrauss.com/wp-content/uploads/2015/03/Full-LCA-Results-Deck-FINAL.pdf; http://www.levi.com/US/en_US/mens-jeans/p/005010194

Car Tire

Continental Tire (per car tire)		
Acquisition of Raw Materials	**%**	**Liters**
Manufacture of synthetic rubber	63%	352.8
Manufacture of rayon	18%	100.8
Manufacture of natural rubber	3%	17.36
Production of steel	6%	31.36
Manufacture of other chemicals	7%	36.4
Sub-Total	**96%**	**560**
Transport		**1.3**
Production		**24**
Use		**44**
Total		**629.3**
Median sales value of tire, F-150 Pickup Tires, Discount Tire, Houston, TX		
High	$409.00	
Low	$103.00	
Implied Continental Realized Unit Price		
High	$306.75	
Low	$77.25	
Value per gallon of water, High	**$1.85**	
Value per gallon of water, Low	**$0.46**	
Value per AF of water, High		$601,255
Value per AF of water, Low		$151,416
AF per Billion USD of Economic Value Generated, High		1,663
AF per Billion USD of Economic Value Generated, Low		6,604
* Converted by multiplying value per liter by 3.78541 to reach the gallon equivalent.		

Thank You!

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